Theme E -- Space Radiation Effects

RECENT RADIATION EFFECTS ACTIVITIES A'J' JPL: Coping with COTS

Charles Barnes and Allan Johnston

Jet Propulsion Laboratory
California Institute of Technology
M.S. 303-220, 4800 Oak Grove Drive
Pasadena, California 91109, USA
(818) 354-4467
(818) 393-4559 (}'AX)

ABSTRACT

The radiation effects and testing programs in place at the Jet Propulsion Laboratory support the insertion of traditional, advanced and emerging microelectronic and photonic technologies in NASA systems through research and testing that enhances the radiation hardness assurance (R] IA) of these technologies. With the decreasing availability of radiation hardened electronics and the ncw NASA paradigm of faster, more aggressive and less expensive space missions, there has been an increasing emphasis on using high performance commercial microelectronic parts and circuits in NASA spacecraft.

The use of commercial parts and circuits (often referred to as commercial off-the-shc]f (COTS)) in space systems poses many potential problems, especially with regard to RHA. The rapid evolution of traditional types of circuits, such as microprocessors and memories, is driven by intense competition in the private sector, and these advances, primarily clue to scaling effects, often result in increased vulnerability to radiation. in addition, radiation testing which reveals that a particular generation of parts is appropriate. for certain close ranges may be rendered irrelevant by the introduction of next-generation versions and the disappearance of the radiation tolerant parts from the market place. The introduction of ncw and emerging technologies that promise greater performance without increased power, weight or volume may have completely unknown radiation effects behavior that must be established through testing. These issues and others will be addressed and discussed within the context of recent radiation effects research and testing activities at J]']. that include the following:

1. Within the last fcw years it has become apparent that certain linear bipolar integrated circuits, such as q-amps, comparators and voltage references, are more sensitive to total ionizing close (TID) at the low dose rate.s characteristic of the space environment than they arc at moderate to high dose rates traditionally employed for total dose RHA testing. This RHA problem is exacerbated by the difficulties associated with doing realistic testing at low dose rates for fast, aggressive space projects. Data demonstrating the enhanced low dose rate (ELDR) effect will be presented along with results of efforts to develop a satisfactory RHA test based on moderate to high dose rate exposure at elevated temperatures.

2. Recent failures of optocouplers on the Topex Spacecraft have highlighted the importance of addressing RHA issues for non-traditional electronics such as optoelectronic devices. LEDs, photodetectors and optocouplers can vary widely in their response to radiation.

Furthermore, displacement damage effects due to protons can be important, as demonstrated by Topex, even though proton fluences are not particularly high for LEO and GEO spacecraft, relative to the magnitude usually required to cause problems in III-V devices. These problems are even more severe in optocouplers that employ phototransistors because of their potential sensitivity to both ionizing radiation and displacement damage. Recent results of proton damage studies of these devices, including comparisons with Topex data, will be presented.

3. High performance scientific instruments aboard spacecraft often require the use of high resolution, high speed analog to digital converters (ADCs). Unfortunately, because there are essentially no radiation tolerant devices of this type available, instrument and spacecraft designers often have to select devices that will not tolerate the anticipated environment. RHA testing of these devices is difficult for both TID and single event effects (SEE), especially when they are BiCMOS. Because of the ELDR effect a BiCMOS ADC can fail by different mechanisms depending on the conditions of radiation exposure. Results demonstrating these effects will be discussed in our presentation.

4. Field programmable gate arrays are particularly attractive for spacecraft use for several reasons. They often allow a significant reduction in the number of parts used on a board, and they can be individually personalized so that a large common buy of parts with established reliability and RHA can be used for several different applications. However, these devices exhibit a variety of radiation effects inducting energetic ion-induced linking of anti-fuse links. Recent SEE and TID results will be presented for Actel FPGAs.

5. Highly autonomous, heavily instrumented spacecraft require large amounts of mass memory to support on-board data processing and storage. Recently, on the Cassini spacecraft for example, this requirement has manifested itself in the use of large numbers of DRAMs for multi-gigabit mass storage as a replacement for tape recorders. TID and SEE studies of DRAMs have revealed interesting effects including the use of retention time as a highly sensitive measure of TID response and the observation of what appear to be two types of hard errors induced by energetic ions. These results will be discussed in our presentation.

6. An exciting new class of devices are microelectromechanical systems (MEMS) in which microelectronics are combined with miniaturized mechanical devices on a single chip. These devices allow reductions in size of a wide variety of functional elements that are used on spacecraft. MEMS devices can be sensitive to radiation for two reasons: 1) the electronics on the chip can exhibit radiation responses, and 2) certain types of mechanical devices, such as cantilevers that depend on capacitive charge for spatial displacement, can also conceivably be sensitive to radiation. We will present recent results of total dose studies of microaccelerometers that suggest that both types of radiation sensitivities are exhibited by these devices.

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This information is also available on the ESTEC Web Server (http://www.estec.esa.nl)

3rd ESA ELECTRONIC COMPONENTS CONFERENCE
21 -25 April 1997
ESTEC,NOORDWIJK, THE NETHERLANDS

Introduction

The third ESA Electronic Components Conference, wi" be he'd in a time of 'ast and turbu'ent change 'or space programmes in the way that they procure and assure components. In a diminishing market for high re'iability components new methods are sought and deve'oped and existing ways of work and management are questioned and changed. The conference wi" re'ect these deve'opments in assurance, management and standardisation methods within European and internationa' space programmes. Advancements in component technO'ogies and physics, 'esting and measurement techniques and to'erance to the space environment wi" a'so 'orm part of the conference programme.

Within the scope of the conference a" major activities re'ating to se'ection, procurement, contro' and utilisation of e'ectronic, e'ectrica' and e'ectromechanica' components 'or space application wi" be addressed with particu'ar emphasis on assurance and standardisation methodo'ogies, component cost matters, new component 'technologies and assessment methods.

'nvited papers wi" highlight the major topics and Pane'/Round Tab'e discussions wi" be he'd on key issues. Tutoria' and poster sessions are foreseen.

'n the same way as in the previous successfu' conferences, this third ESA E'ectronic Components Conference wi" provide ample opportunities for project and corporate managers, engineers and scientists to exchange ideas and information on e'ectronic component subjects.

The Con'erence wi" be organised in themes covering the 'o"owing subjects:

THEME A: COMPONENT ENGINEERING AND TECHNOLOGY

Theme A wi" discuss component 'echno'ogy and physics, 'est and inspection methodo'ogy, applications, 'ailure modes etc. The 'o"owing wi" be addressed:
— new component 'echno'ogies and applications,
— new eva'uation methods and e"iciency o' testing 'echniques,
— re'iabi"ty studies and eva'uation of 'ai'ure modes,
— component eva'uation and approva' programmes,
— component 'ailure experience in space systems.

THEME B: COMPONENT PACKAGING AND ASSEMBLY

Theme B wi" discuss the rapid deve'opment in component packaging 'echniques and re'ated assembly methods. Special attention wi" be given to the 'o"owing:
— high pin count packages 'or comp'ex integrated circuits,
— usage of p'astic packages 'or space applications,
— packages 'or microwave and V'VIC components,
— sur'ace mount devices and 'echno'ogies,
— packages 'or high power dissipation devices,
— mu'tichip modules,
— approaches 'or chips, wa'ers and known good die.

THEME C: COMPONENT STANDARDISATION, SPECIFICATION AND ASSESSMENT

Theme C wi" discuss the deve'opments in internationa' and nationa' component standardisation and specification systems and address new component assessment methods. The 'o"owing wi" be addressed:
— internationa' and nationa' standards and specification systems,
— best commercia' practices, synergy with other markets,
— TQV, QML, 'echno'ogy and capabi"ty approva',
— certification and assurance concepts,
— commercia' part adaptation to space uti'isation.

THEME D: COMPONENT PROCUREMENT, COST AND PROGRAMMATIC ASPECTS

Theme D wi" address pro'ems in ava'ability and cost o' (key) components 'or space programmes ranging 'rom microsate"ites to space stations as we" as organisation and contro' of component procurements and storage.

The 'o"owing items are o' interest:
— 'ype reduction, PPL and part approva' procedures, cost o' ownership, component costs and procureme' costs,
component stores and 'est and assemb'y houses, non conformance and a'ert systems,
— procurement approach vs system and mission comp'exity,
— component data management and dissemination

THEME E: SPACE RADIATION EFFECTS

Theme E will discuss the influence of space radiation o' e'ectronic components and wi" address:
— impact of radiation on component re'iability,
— radiation countermeasures,
radiation hardness assurance of components,
packages 'or improvement of radiation to'erance cosmic ray, to'a' dose and proton test data.

CALL FOR PAPERS

Authors are requested to prepare extended abstracts (2 pages) providing su"icient deta's to permit a meaning review. 'n addition a summary o' not more than 35 word: requested 'or inc'usion in the second announcement a pre'iminary programme.

Presentations wi' be se'ected by the Program Committee on the basis o' the 'o"owing:
- genera' interest o' the subject,
- qua'ity of the conten',
- originality and innovativeness of the ideas.

Abstracts may be submitted:
- by using the 'orm on the www, 'o transfer or e-mai' attachment (p'ease use only p'ain 'ext);
- by mai',
- by 'ax ('o"owed by an origina' copy in the mai')

Abstracts shou'd contain the 'o"owing information:
- 'itle of the paper (centred) and proposed Theme,
- author(s) name(s)
- a"iliation of the author(s)

The 'u" address of the contact person, inclu' te'ephone/'ax numbers and e-mai' address shou'd be giv separate'y.